

Analysis and Rectification of Factors Contributing Delays in Construction of Power Projects

Ganesh Kumar Pamarthi, Tejaswini Borra



Ganesh Kumar



Tejaswini

Abstract— This paper aims at identifying various factors of delays during the capacity planning and the execution phase of BoP by using suitable delay analysis techniques. Delay analysis is the technique used to identify causes of delay and the impact they have on the progress and completion of a project. It is necessary in some form for claims for extensions of time and cost of prolongation. Without it a contractor will fail to demonstrate any entitlement. It is crucial to any claim that the most appropriate method of delay analysis is adopted. If we choose a method that fails to deal with issues such as culpable delays, concurrent delays and changes in logic then the claim might be easily rebutted. Whereas, using a sophisticated method for a simple issue can be a waste of time and money. A number of factors influence the selection of approach including the requirements of the contract, quality of the contractor's planned programme, quality and extent of records and the complexity of the issue.

Index Terms— Construction Industry, Power Plants, Delays Analysis, Damages, Factors, Disputes, Time overrun, Clients, Contractors

1 INTRODUCTION

THIS paper mainly highlights on finding the major factors with the perspective of client and contractor for delay damages. Delay analysis is a widely debated construction law subject due to the number of projects that are not completed on time, the financial implications of late completion and the often quite different conclusions that can result depending upon the method of analysis used.

The BoP or Balance of Plant system comprises of all the system and utilities which are required to run thermal power plants starting from raw material input to waste output apart from the power island which includes the generator, turbine and boiler with its auxiliaries.

In reality nearly all projects of any substantial size experience changes and/or delays, therefore the parties are well served by thinking about how they will handle changes and delays prior to the start of execution. Setting out a frame work in the contract for dealing with this inevitability is in the interest of both the contractor and the owner.

This study aims at identifying various factors of delays during the capacity planning and the execution phase of BoP and suggesting recommendations. Delay analysis is the technique used to identify causes of delay and the impact they have on the progress and completion of a project. It is necessary in some form for claims for extensions of time and cost of pro-

longation. Without it a contractor will fail to demonstrate any entitlement.

Delays are most prevalent in the power sectors due to the vast scale of the projects and causes huge amount of losses to both the owner and the contractor. Hence it would be a worthwhile effort to use the above mentioned delay analysis techniques to analyze delays in power project which will result in saving large sums of money and would help in making the country self-sustaining.

2 INDIAN POWER SCENARIO

In recent years, India's energy consumption has been increasing at one of the fastest rates in the world due to population growth and economic development. In the past decade, with the global focus shifting on India and China, the task of developing a strong backbone in terms of our infrastructure has come on the fore front, for which electricity is the most critical component. In today's time and over the past few years; the Government of India has strived hard to meet the demand for this basic requirement of its people. Post the Electricity Act, 2003, which provide an enabling framework for accelerated and more efficient development of the sector significant reforms have been witnessed till date. Section 3(1) of the Electricity Act, 2003, required the Central Government to formulate the National Electricity Policy (NEP), in consultation with other stakeholders. Accordingly, the NEP was released in February 2005, and aimed at providing operating at that time. Today, after years of reforms in the power sector the country is still far behind its ambitious goals. A short peek at our past performances indicates that during the last three five year's

- Ganesh Kumar Pamarthi is currently pursuing masters degree program in Thermal engineering in JNTUK, India, Mobile +917043044935. E-mail: ganeshpamarthi@hotmail.com
- Tejaswini Borra is currently pursuing masters degree program in Mechanical Engineering in JNTUH, India, Mobile +917226933354. E-mail: tejaswiniGANESH@hotmail.com

plans (8th, 9th and 10th); we have barely managed to achieve half of the capacity addition that was planned. As we enter the third year of the 12th five year plan, we have already seen slippages on the planned approx. 81 GW capacity addition. At least for the last ten years, the shortage during peak hours has been well above the per cent. The peak load deficit on an all India basis for the financial year 2013-14 was 15.1% till April'14.

The entire value chain of the power sector is dominated by the central and state sector utilities. At present majority of the India's power needs are satisfied through thermal power, based mainly on coal and gas.

The Indian economy has been growing at above 8 percent for the last few years. To sustain this growth rate, the role of power sector becomes very important. As espoused by economists and industry experts, the market potential to sustain the GDP Growth rate of India @ 8% plus per annum requires the power sector to grow at 1.8 - 2 times the GDP rate of growth. This would mean a year-on-year capacity addition of around 18,000 - 20,000 MW. The drive to increase the country's generating capacity led to inviting foreign investors in the country and setting up Independent Power Plants (IPPs) in India. While dozens of projects have been approved, most of the projects are stalled by delays which occurred due to various reasons. There has been a quantum increase in the investment in the power sector. In the beginning of the X Plan (April, 2002), about 24,000MW worth projects with the estimated cost of \$20,568 million were under execution. 46 of these projects (14,300 MW) have been completed. At present, 83 power generation projects are under execution.

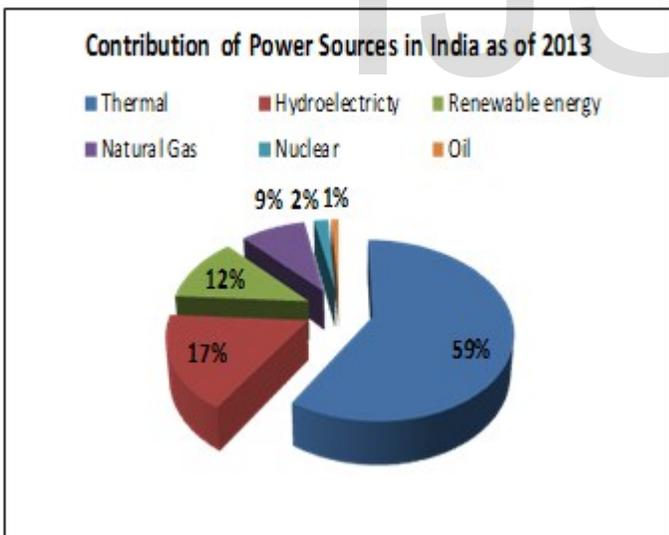


Figure 1 Contribution of Power Sources in India.

2.1 Need for expedition

India has historically failed to meet its power sector targets by a significant margin and with tremendous opportunities ahead. The power sector continues to be affected by the short-fall both on generation as well as transmission side. For example, for the current installed capacity of around 152 GW, the

inter-regional transmission capacity is only about 20 GW (13 percent of the installed capacity). The various proposals in generation and transmission are currently under different implementation stages. However, the power sector in India has been plagued with a set of problems for meeting the planned targets. Although measures have been defined by the policy-makers and stakeholders in a sense of complacency that the issues will indeed be resolved and India will plug the supply deficit of power to resolve the same but looking at the past record, it can be estimated that the resolution measures may not be implemented. The biggest indicator of a poor track record is the inability to meet targets on the power generation capacity additions. Variance with the target has been as high as 50 percent in the past. An indication of targets and actual additions is provided in the Figure 2

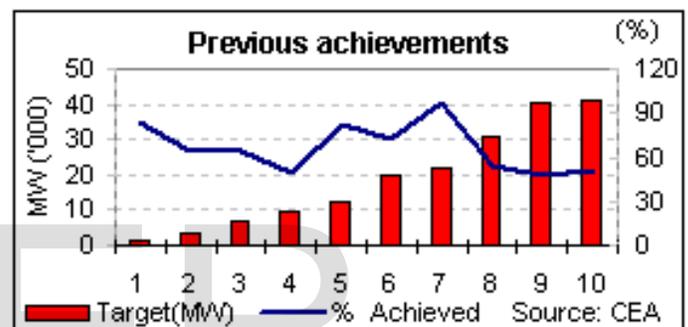


Figure 2 Plan Targets Vs Achievements (MW)

3 METHODOLOGY

For the purpose of mini thesis in literature survey only secondary data is collected and analysed.

The secondary data is obtained from ProQuest, other websites, International Journal of Project Management, Books and Publications on the related topic and field.

International Journal of Project Management was a good source available in the college library; it has quality information related to the topic and is a reputed journal in the project management field.

While conducting the survey it has been observed that very few papers are available on delays of projects in Indian Context and for projects going on in India. Cases of project delays in the execution of Thermal power projects in Andhra Pradesh is considered and reasons for the above delays have been identified. Also, general causes crippling power project progress have been identified and recommendations are suggested.

For future study, primary data from on-going power projects would be collected and the causes of the delays would be analysed and possible solutions for the identified causes will be done. Also, solutions will be provided to prevent to prevent future delays in similar projects.

4 DELAY ANALYSIS

4.1 Causes for Delays

During the development phase, the project sponsoring department prepares the estimates of project works as well as of the time and the cost (funds) needed to complete project works. These estimates are approved by the appropriate authority in the department. In addition, a project generally requires approval from several other departments. In the beginning of the next, that is, the construction or the implementation phase a contract is signed between the sponsoring department and a contractor. Depending on the context, the contract can be for construction or for procurement of equipment's or both. During this second phase, timely completion of the project often requires active cooperation from the sponsoring authority, the contractor(s) and several other departments. Therefore, whether a project can be delivered in time and on cost depends on how well the activities and efforts of the departments involved and the individuals concerned are coordinated. The activities and efforts of the parties involved are governed by two different modes of governance. The activities of the contractors are governed by market contracts signed between the sponsoring department and the contractor. As will be shown in the following, the natures of the contract and subsequently its enforcement have profound implications for delays and cost overruns. On the other hand, efforts of the officials involved in project planning and implementation are governed by the organizational structure of the government departments. Government organizations are hierarchical in nature. Hierarchy based organizations are inherently weak in inducing the desired efforts from individuals concerned. The problem is acuter for government organizations. Therefore, both contractual and organizational modes of governance are subject to failures. The following section discusses what kind of contractual and organizational failures are major causes of delays and cost overruns in India. For the ease of exposition, it is helpful to divide the set of possible causes in the following

1. **Technical and Natural Factors:** The estimation of project time and cost for power projects, especially for BOP, is a characteristically complex exercise as it involves a myriad of interdependent equipment's, of delay during the procurement or the execution can severely hamper the progress of the project. Also the delay can be very difficult to trace as the as the BOP package consists of all the ancillary units. Though the estimation techniques have become better and sophisticated in recent times, they are still imperfect. As work on a project starts, its future unfolds and the authorities along with the contractor become better informed about the specific technological and material requirements of the project works. For example, during construction of the pipe, an unexpectedly poor quality of soil may necessitate changes in the engineering, the design and the quality of pipe rack structure required, from what were initially planned. Such changes may require extra time as well as funds. In some cases the actual circumstances, in contrast, may turn out to be favourable and the parties may find that they had made excessive provisions of funds and

time. Similarly, flood or any other event of force majeure may cause delay as well as destroy the project assets. Alternatively, the natural conditions may turn out to be rather conducive, saving construction time and costs. Therefore, due to imperfect estimation and natural factors the actual project time and cost will generally be different from their expected values. However, one would expect the effects of the technical and natural factors to be random without any bias. Also, due to the above-discussed learning-by-doing among officials, both the delays and the cost overrun would be expected to come down over the years. Therefore, if the decline in the delays and cost overruns over the years turns out to be statistically significant, we can attribute some of the delays and cost overruns to the technical and natural constraints. However, as they move up the learning curve, learning among officials and its efficacy in reducing delays and cost overruns will come down. By the same account, the effects of policy interventions are expected to decline over time. Therefore, starting from mid-seventies, percentage delays and cost overruns are expected to have come down over time, but at a 'decreasing rate'.

2. **The Contractual Failures:** As discussed before, the construction phase of a power project, like any other infrastructure project, starts with signing of a construction/procurement contract. In terms of figure given below, the contract is signed between the authority (employer) and the contractor at date $t=1$. It specifies the works that are to be performed, or the good that is to be delivered by the contractor. The degree of precision in this initial contract has direct implications for cost overruns.
3. Suppose the initial contract is contingency-complete in that it fully specifies all the works that are to be carried out in each possible contingency that may arise during the construction phase. Under such a contract, cost overruns can be avoided altogether. Since every contingency has been completely planned for, no additional (un-specified) work is ever required. Now, if the initial cost is determined for each contingency, there will be no cost overruns. Moreover, the contract price can be fixed or can be contingency specific. In either case, the parties' obligations have already been spelt out fully. No 'additional' payment is required to be made by the either party. In fact, delays on the part of contractor can also be avoided with the help of suitable penalty clauses. Therefore, in principle, complete-contingent-contracts can ensure that project is completed in time and within (contingency-specific) budget. In reality, the initial contract cannot be complete. Parties cannot predict every possible scenario that may unfold during the construction phase. As a result, the initial contract cannot completely specify every relevant aspect of the project works; different states of nature during con-

struction require different modifications in the project works. For example, the chimney height may have to be increased if the Ministry of Environmental Protection passes a bill on the minimum chimney height. The bounded rationality of the parties along with imperfect forecasting techniques makes it impossible to specify every contingency and the relevant tasks to the last details. As a result, the initial contract leaves out several project works. This is especially true of power projects, which are inherently complex and have long building phase. Formally speaking, the initial contracts for power projects are intrinsically 'incomplete'. Once the contractor starts the work at the project site and the future unfolds, the need for additional works arises invariably. Additional works require more funds and hence cause cost overruns. In some cases, extra time is also needed. So, some of the cost overruns are caused by what we have called the contractual incompleteness. Construction projects are typically more complex and therefore more difficult to plan and execute than is the case with non-construction projects, say, those involving purchase of equipment's. So, the degree of incompleteness of the initial contracts is expected to be higher for construction projects. Each project in power sector is generally unique in terms of its requirements. So, learning from previous projects is limited. If our claim about the causal relation between the contractual incompleteness and the cost overruns is correct, the cost overruns experienced by projects in the power sector should be significantly larger than by other sector projects.

4. The contractual incompleteness is expected to increase with the project size. Since, compared to smaller ones, bigger projects involve more works. Besides, big projects like Ultra Mega Power Plants (UMPP) are generally more complex than the smaller ones. It is plausible to argue that the contractual incompleteness increases with the project size. Therefore, the resulting cost overruns are also expected to grow with the project size. The initially expected project cost is a good measure of project size, its complexity, and hence of the contractual incompleteness. So, cost overruns are also expected to swell with the initial cost, at least in absolute terms. But the same cannot be said for percentage cost overruns. For a given degree of contractual incompleteness, percentage cost overruns need not increase with the project size.
5. Sometimes it happens that the initially expected project cost, rather than the actual cost, is a better indicator of the size and incompleteness of the contract. Due to cost overrun, the final cost can be large even for small projects. The same argument applies to the implementation phase.
6. To take an example, suppose a project is worth Rs 100 crore. But, the initial contract misses out on say ten

percent of relevant work. As a result, there are cost overruns of Rs 10 crore. Take another same-sector project that is worth Rs 200 crore. This bigger project may show higher cost overruns of Rs 20 crore. But, percentage cost overrun for both projects is the same; 10 percent. Of course, as complexity of a project increases, it becomes more difficult to provide every minute detail in the initial contract. Under unit-price EPC contracts, the contractor gets paid based on the quantities of inputs used. Therefore, he does not have to worry too much about details of material requirements.

7. However, if project planning is poor, cost overruns can increase with project size not only in absolute but also in percentage terms. To see why, first of all note that the initial contract can be made more or less incomplete by the parties involved. If project planning is bad and apathetic, estimates of project time and cost will be vague and so will be the initial contract. As a result, many un-contracted for works will become necessary later on, leading to high cost overruns and inevitably time overruns. In contrast, a meticulous planning in terms of technical and material requirements of the project can enable the parties to stipulate most of work details in the initial contract itself. This, in turn, means less frequent and lower cost overruns. The problem, however, is that careful planning is a tedious work. Planning of big and complex power projects (UMPP) require all the more of painstaking and drawn out efforts. If there is no accountability, the officials will have no incentives to put in the desired efforts at the planning and contracting stages. Certainly, quality of efforts put in will not increase in sync with the project size and its complexity. Since, bigger projects entail not only more works but also more complex ones; the initial contracts for bigger projects will become more incomplete. This, in turn, means a larger proportion of additional, uncontracted for, works will have to be undertaken during the construction phase. To sum up, if project planning is sloppy, the greater is the project size and its complexity, the higher will be the proportion of project works that gets left out of the initial contract. So, if project planning is defective, the greater is the project size the larger will be the cost overruns.
8. Project planning processes in India are infamous for their ad-hoc and shoddy approach. Detailed project reports (DPRs) as well as feasibility reports are sloppy and vague, prepared only for the sake of formality. This problem is further exacerbated by the use of unit-price EPC contracts. Under these contracts neither the officials nor the contractors find it worth haggling over work details. On this count also, contractual incompleteness increases with project size. If the above arguments regarding the deficient project planning in India are the consequent contractual are correct, the percentage cost overruns should increase

with the project size. Therefore, we have another testable hypothesis: the greater is the initial costs, the larger is the percentage cost overrun, and vice-versa.

9. **Organizational or Institutional Failures:** As argued above, execution of power projects requires active cooperation of several departments within as well as among various ministries. Government departments are hierarchical organizations. A large body of literature shows that there is a conflict between the individual and the organizational objectives at every stage of hierarchy. As a result, hierarchical organizations are inherently weak in inducing the desired efforts from the people involved. This is especially true of government organizations. Therefore, power projects have to face the consequences of organizational failures within the sponsoring ministry itself. On top of it, these projects need joint efforts of several other organizations. In India, different departments are responsible for different project activities. For example, project implementation, shifting of power lines, water lines, sewer lines, cutting of trees, environmental clearances and other such activities are performed by different departments. Executions of these activities are highly dependent on joint and timely efforts of the departments involved. However, interdependence of efforts means that it is easy for departments to shirk and pass the blame on others. So, in addition to intra-organizational failures, power projects in India are vulnerable to inter-organization failures. Several reports, including the official ones, corroborate our claims.
10. **Thermal power projects generally require environmental clearance from the central as well as the state agencies.** Moreover, compared to those in the other sectors, these projects require much more active cooperation of several departments for land/property acquisition, shifting of power lines, water lines, sewer lines, approval of under or over-passes, etc. Laxity on the part of just one department or dereliction of duty by a few officials can hold-up the entire project. So, the projects are highly vulnerable to delays caused by all kinds of organizational failures. The same is the case with projects in civil aviation, shipping and ports, and power sectors, though to a lesser extent. Majority of projects these sectors too involve construction or setting of network points. In several cases, ecologically sensitive land has to be acquired. This means more regulations and increased vulnerability to inter-organizational failures. Every department involved in project planning and implementation can suggest changes in project works, and hence can contribute to cost escalations. Similarly, if a project spans across more than one state, it has to deal with the concerned departments in each state. Therefore, projects spanning across multiple states seem more susceptible to inter-organizational failures.
11. **Time Overruns:** Logically, any delay in implementation in itself should cause cost overrun for the project. This should happen simply on account of inflation itself. In most cases, initial cost estimates are arrived at using the current input prices. If there are delays, inputs will become more expensive and, in turn, will cause an increase in the project cost. Moreover, certain overhead costs have to be met as long as the project remains incomplete. Delays should increase these costs also. Also, a long delay may cause depreciation of project assets, necessitating expenses on repairs or replacements. This means that in addition to the above factors, time overrun on account of any other factor is also an underlying cause for cost overruns.
12. **Economic Factors:** Each project is located in some state(s). Several departments of the state government concerned play rather crucial role in project implementation. After all, activities like land-acquisition, shifting of utilities, etc., are performed by the state government concerned. Moreover, economic and geographical features of the state may affect the project time and costs. For example, if a state has better transport, power and telecommunication infrastructure in place, it will be easy to execute projects in the state. Generally, richer states are said to be in possession of superior infrastructure. In contrast, due to law and order as well as difficult terrain, project implementation is likely to be difficult in the North-Eastern states and Jammu and Kashmir.
 - a.
13. **Equipment Shortage:** Equipment shortages have been a significant reason for India missing its capacity addition targets for the 10th five year plan. While the shortage has been primarily in the core components of Boilers, Turbines and Generators, there has been lack of adequate supply of Balance of Plant (BOP) equipment as well. These include coal-handling, ash handling plants, etc. Apart from these, there is shortage of construction equipment as well.
14. To alleviate supply shortage of equipment one of the following two measures are to be adopted - enhancement of domestic equipment manufacturing capability by establishing JVs between Indian and foreign suppliers and second measure is procuring equipment directly from international markets. In both cases equipment sourcing needs to be managed effectively throughout the procurement cycle. For instance, it may be a challenge for new project owners to select a reliable supplier, monitor its performance and ensure the quality of supply on a sustained basis. Also, the timelines for availability of additional domestic equipment supply has to be clearly defined.
15. **Manpower Shortage:** There is a general consensus that shortage of talent in the construction sector is a long term problem and is likely to continue to push up project costs and risks. The flow of talent into construction and power sector has been gradually drying

up as candidates have sought an alternative – and often more lucrative – career options. The Government, which is the biggest buyer of the capital projects, has also not done enough to address this challenge. The education system is often not delivering the required number of specialists across project management, engineering, estimating, surveying and contract management. Facing a desperate game of catch up, the industry needs a genuine collaboration between project owners, contractors and governments to attract more school leavers and graduates. Companies should also seek to stay in touch with changing employee aspirations. By encouraging diversity in its employment practices and by offering greater flexibility in working hours, the sector can reach out to a wider potential audience that perhaps would not previously have considered such a career. Investment in existing employees is also crucial in order to offer better-defined career structures, with greater focus on training and higher salaries where possible.

4.2 Project Management Principles to Address Delays

A common theme across the challenges enumerated earlier is the need for sound project management principles in a well-structured framework. This is likely to enable the project owner to clearly evaluate all aspects of project execution across the project lifecycle. A sound project reporting system enables the project owner to efficiently keep track of all the aspects of project execution thus helping ensure problems are addressed and resolved in a timely manner.

4.2.1 Phases of Project Lifecycle

The project management framework shown above can contribute to a structured manner of addressing the typical challenges of the Indian power sector throughout the project lifecycle and aid in managing the power projects better. The main buckets under which all the challenges of the power sector can be addressed are:

- i. Project Strategy, Organization & Administration
- ii. Cost and Financial Management
- iii. Procurement Management

v. Schedule Management

By tracking each of the aspects in a well-defined framework, the reporting on project execution becomes focused. Few examples of how some processes of the framework can address the major challenges are illustrated in the [Figure 1](#)

4.3 Procurement planning and management

This is a key element which is essential to execute and monitor a project successfully. A detailed procurement level planning that can address the current challenges of fuel availability and equipment shortage. By addressing the constraints of coal transportation through Indian railways and ports availability, a realistic procurement plan can be prepared showing the overall impact on the achievement of the 11th plan. Addressing these constraints upfront can bring the needed transparency upfront and is likely to trigger the corrective actions on timely basis in case of negative deviations.

Planning for construction equipment's becomes a critical aspect of procurement planning, achievement of which can assess the vendors' reliability and provide well established vendors to be used for future projects

4.3.1 Stakeholder Identification and Communication Planning

Stakeholder identification is required in the project's early stages to measure their expectations and assess their impact on the overall project life-cycle. The impact can be on the design or construction scheme which can adversely affect the

project schedule and budget. Therefore, R&R and clearance planning should be in place before the project plan is finalized. Communication planning can eliminate the mismatch between stakeholders' expectations, helping ensure the buy-in from all affected parties to prevent any hurdles in the future. For example, all the project affected persons (PAPs) should be consistently involved through-out the project to make the planning for balance work realistic and achievable. The fact that land acquisition and permits are major concerns for captive coal blocks operations exemplifies that stakeholder identification and communication planning was missing during the 11th plan formulation.

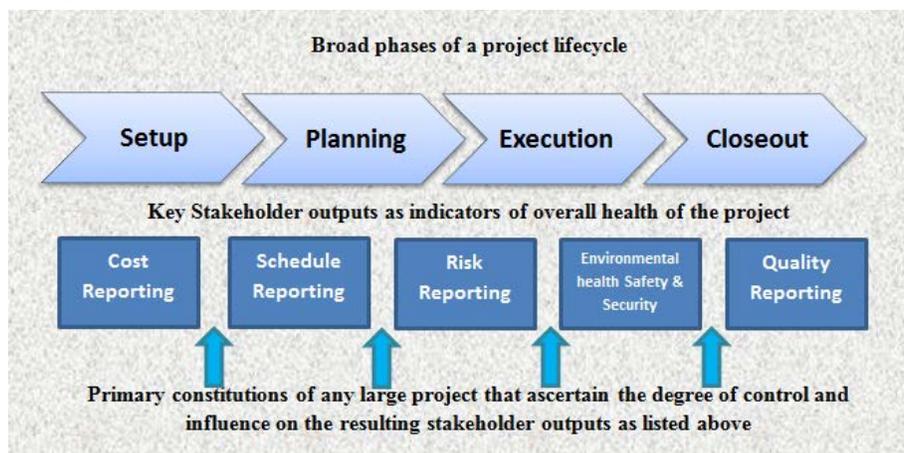


Figure 4 Phases of a project lifecycle

- iv. Project Controls, Quality & Risk Management

4.3.2 Schedule Integration

Schedule integration enables building a detailed master schedule where dependencies across different projects plans and external factors can be built in and addressed regularly. Schedule integration is the key to avoid any gaps and mismatch between stakeholders' planning and expectations. The impact of major dependencies such as equipment supply (BTG etc.), land acquisition and R&R, and environment clearances can be ascertained in the master schedule and addressed prudently.

5 RECOMMENDATIONS

1. There is a need to substantially augment existing indigenous manufacturing facilities as well as to create additional capacity by new players in the Thermal and Hydro main plant equipment's.
2. BHEL should play an active role in development of ancillaries units/ vendors commensurate with their own enhanced capacity and to ensure that deliveries are complete and sequential.
3. Advance procurement action is required for some of the critical long lead inputs namely, critical castings and forgings for Turbines and Generators, Boiler quality plates, P-91 piping, CRGO sheet steel for Transformers, z, where world-wide shortages are being currently experienced. These items are being imported and the vendors available globally for these items are very few. It is also necessary to encourage indigenous industry to set up capacity in these areas as there is a spurt in power plant business worldwide.
4. Balance of Plant were identified as critical items for timely commissioning of Thermal Power Projects. It was observed that a number of Thermal units were getting delayed due to delay in commissioning of Balance of Plants such as Coal handling plants, Ash handling plants, cooling tower etc. There is a need to develop more vendors for the following Balance of Plants;
 - i. Ash handling plant.
 - ii. Coal handling plant.
 - iii. DM Plant.
 - iv. Condensate polishing unit.
 - v. CW and make up system.
 - vi. Cooling tower.
 - vii. Air compressors.
 - viii. Chimney.
 - ix. Desalination plant.
5. There are very limited vendors for each of above BOPs and at times only single quotation is received. There is a need to develop adequate erection and construction agencies for executing civil and mechanical works and engineering consultants for engineering

and design of various packages

6. Stringent qualifying requirements for the vendors specified by utilities to be reviewed so that it should not act as deterrent for participation by new players. It was felt that the new players could be qualified based on proven management experience provided they meet the financial requirements. New players could, however, be asked for additional performance guarantee.
7. IT based project management & monitoring should be introduced at all the project sites with on line connectivity with suppliers, project authorities, EPC contractors and CEA.
8. There is a shortage of skilled man power at the project sites resulting in delay in their implementation. The project developers and major EPC contractors have to contribute in building up a large skilled man power pool for power sector. There was a consensus that each project developer and major EPC contractors should adopt ITIs near the project area and organize project specific training to obtain skilled workers for them and their contractors/ sub-contractors and to ensure local availability of skilled man power.
9. The transportation facilities including port handling facilities for equipment and fuel needs to be enhanced commensurate with capacity addition.
10. Adequate fuel availability has to be ensured for the proposed plants. Coal block allotment/coal linkage for all plants, which are proposed to be commissioned during the 11th plan, should be made on priority.

6 CONCLUSION

Timely completion of power projects is very crucial to the development of our country. The complexity of work involved in power project and the involvement of several parties like government, environmental agencies, owner (power utility), contractors and sub-contractors make the timely completion of power project a very challenging task. Delay in power project can be due to several reasons like delay in land acquisition, delay in supply of equipment's, delay in approval of drawing and design documents, etc.

Study of the contract agreement between the owner and the contractor suggests that the existing contract document has a lot of loop holes and lacks any clear cut measure to check the delay at different stages of power project. By incorporating suitable measures and defining strict norms and penalties for completing each of the individual activities in the contract document, we can bring substantial improvement in the timely completion of the power project.

Table 1 Sustainable measures undertaken for completion of Project

Key Challenges	Measures being adopted	Resulting issues	Drivers for determining success
Addition of Significant Generating capacity	UMPP	Technical and financial capability to execute such large projects	Project execution Costs/Cash flow management
Ensuring fuel availability and quality	Purchase and development of coal mines abroad	Risks in operating in different geographies. E.g. – political risks	Risk management through effective contracting, supply diversification, etc.
Plant equipment shortage	Procurement from abroad	Uncertainties in logistic operations Vendor reliability	Control over supply infrastructure Product procurement management Vendor management
Land acquisition and environment clearances	Setting up of new supply units Speeding up processes	Execution timelines Inadequate communication with stakeholders resulting in mismatch of expectations from prom project affected persons	Project scheduling Environment and stakeholder management
Manpower shortage	Enhance training	--	Resource planning and management

7 REFERENCES

7.1 Papers and Reports

- [1] A.S.Bakshi, 'Overview of Power sector – 12th Plan and Beyond', CEA, New Delhi, 2009
- [2] Report of working group on power for eleventh plan (2007-2012) Volume-II, Ministry of power, Government of India, New Delhi
- [3] Neeraj Kumar Ojha, 'Delay in Power Projects', IIT Kanpur
- [4] 'Power Sector in India - White paper on Implementation Challenges and Opportunities' KPMG, Nagpur, Jan, 2010
- [5] Ahmed, S.M. (2000). Construction Delays in Florida: An Empirical Study.
- [6] International Journal of Project Management.
- [7] Aibinu, A. A. and Jagboro,G.O.(2002).The Effects of Construction Delays on
- [8] Project Delivery in Nigerian Construction Industry. International Journal of
- [9] Project Management, Volume 20, Issue 8, November 2002, Pages 593-599.
- [10] Alaghbari, W. et al. (2007). The Significant Factors Causing Delay of Building
- [11] Construction Project in Malaysia.
- [12] Arditi, D. and Pattanakitchamroon, T. (2006). Selecting a Delays Analysis
- [13] Method in Resolving Construction Claims. International Journal of Project
- [14] Long L.H., Lee Y.D. and Lee J.Y (2008). Delay and Cost Overruns in Vietnam
- [15] Large Construction: A Comparison with Other Selected Countries. KSCE
- [16] Journal of Civil Engineering. Volume 12. Issue 6. Pages 367-377
- [17] Majid, I.A. (2006). Causes and Effects of Delays in Aceh Construction Industry.
- [18] Master of Science in Construction Management. Universiti Teknologi
- [19] Malaysia. 2006
- [20] Manavazhia MR, Adhikarib DK. Material and Equipment Procurement Delays in
- [21] Highway Projects in Nepal. International Journal Project Management 2002;

- [22] Naha, N.E. (2008). Project Delay in Construction. Degree of Civil Engineering
- [23] Bassioni, H.A. and El-Razak (2008). Causes of Delays in Building Construction
- [24] Projects in Egypt. Journal of Construction Engineering and Management.
- [25] Hamid, M.A. and Torrance, J.V.(2006). Factors Influencing the Construction
- [26] Time of Civil Engineering Project in Malaysia. Journal of Engineering
- [27] Construction and Architectural Management. Volume 13. Issue 5.
- [28] Kaliba, C., Muya, M. & Mumba, K.(2009). Cost Escalation and Schedule Delays
- [29] in Road Construction Projects in Zambia. International Journal of Project

7.2 General sources

- [A] Construction Update (www.constructionupdate.com)
- [B] Projects Monitor (www.projectsmonitor.com)
- [C] The Hindu (www.thehindubusinessline.com)
- [D] Proquest (www.proquest.com)
- [E] Science Direct (www.sciencedirect.com)
- [F] Economic Times (www.economictimes.indiatimes.com)
- [G] Business Today (www.businesstoday.intoday.in)
- [H] Business-standard (www.business-standard.com)
- [I] Business World (www.businessworld.in)
- [J] Tribune India (www.tribuneindia.com)
- [K] DNA India (www.dnaindia.com)
- [L] Scribd (www.scribd.com)
- [M] Wikipedia (<http://en.wikipedia.org>)

7.3 Books and journals

- [I] Power plant Engineering Journal
- [II] International Journal of Project Management
- [III] Indian Infrastructure Magazine

Bibliography of the Authors

1. Ganesh Kumar Pamarthi

Post Graduate Mechanical Engineer, working as Manager with Reliance Industries Limited in World's Largest Refinery and having total work experience of **8** years in structural, piping, equipments and mechanical construction activities involved in administering, organizing and executing different phases of construction in Oil and Gas, Petrochemical & Power Projects.

2. Tejaswini Borra

Post Graduate Mechanical Engineer, with total experience of **4** years in **Structural Engineering**. MSC certified in NASTRAN and PATRAN / with knowledge in Design Engineering (CAD/CAE), Metal forming tool (Press) Design, Aero-Structures, Fatigue and damage Tolerance/ developed many VBA-Excel macros.